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ABSTRACT

Recent research in the human ecological tradition has made increasing use of causal modeling in the search for understanding of aggregate-level social processes. This approach has great appeal because it helps make hypotheses explicit, provides a convenient way to structure the application of statistical controls, allows the representation of complexity in the relations among variables, and if some strong assumptions are plausible, it makes possible weak probes of causal hypotheses using only correlational evidence. The present report critically examines the utility of the path analytic approach in human ecology by using the rate of high school crimes reported to the police as an example and providing some tests of the plausibility of the underlying assumptions of this research strategy. It is concluded that in studies like the one exemplified here it is difficult to have confidence in the interpretation of results, and that alternative approaches may be more fruitful. These alternative approaches should be given attention by research policy-makers. (Author)

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MODELS AND MUDDLES IN HUMAN ECOLOGY: AN EXAMINATION OF HIGH SCHOOL CRIME RATES

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Introductory Statement

The Center for Social Organization of Schools has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organization.

The Center works through four programs to achieve its objectives. The Policy Studies in School Desegregation program applies the basic theories of social organization of schools to study the internal conditions of desegregated schools, the feasibility of alternative desegregation policies, and the interrelation of school desegregation with other equity issues such as housing and job desegregation. The School Organization program is currently concerned with authority-control structures, task structures, reward systems, and peer group processes in schools. It has produced a large-scale study of the effects of open schools, has developed Student Team Learning Instructional processes for teaching various subjects in elementary and secondary schools, and has produced a computerized system for school-wide attendance monitoring. The School Process and Career Development program is studying transitions from high school to post secondary institutions and the role of schooling in the development of career plans and the actualization of labor market outcomes. The Studies in Delinquency and School Environments program is examining the interaction of school environments, school experiences, and individual characteristics in relation to in-school and later-life delinquency.

This report, prepared by the Studies in Delinquency and School Environments program, examines the utility of path analysis as a method for analyzing aggregate-level data on high school crime rates.

Abstract

Recent research in the human ecological tradition has made increasing use of causal modeling in the search for understanding of aggregate-level social processes. This approach has great appeal because it helps make hypotheses explicit, provides a convenient way to structure the application of statistical controls, allows the representation of complexity in the relations among variables, and if some strong assumptions are plausible it makes possible weak probes of causal hypotheses using only correlational evidence. The present report critically examines the utility of the path analytic approach in human ecology by using the rate of high school crimes reported to the police as an example and providing some tests of the plausibility of the underlying assumptions of this research strategy. It is concluded that in studies like the one exemplified here it is difficult to have confidence in the interpretation of results, and that alternative approaches may be more fruitful. These alternative approaches should be given attention by research policy makers.

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Models and Muddles in Human Ecology:

An Examination of High School Crime Rates

Human ecological analysis is the aggregate-level study of the characteristics of human populations and their environments. This kind of research has a substantial history in social science (Hawley, 1950; Robinson, 1950), and ecological analysis has recently been applied to studies of the deterrent effects of penal sanctions on crime rates (Blumstein et al., 1978), the geographical distribution of crimes (Harries, 1976), the distribution of health workers (Fox and Richards, 1977; Richards, 1977; Richards and Gottfredson, 1978), to studies of school system characteristics and aggregate academic achievement (Bidwell and Kasarda, 1975, 1976; Alexander and Griffin, 1976), to examination of the impact of Supreme Court decisions (Richards, 1978), and to efforts to understand class power and state policy (Hicks et al., 1978) among other topics. Increasingly, human ecological research has incorporated causal modeling techniques in attempts to unravel complex problems using correlational evidence.

Path analysis has great appeal in ecological studies because it (a) provides a convenient way to structure the application of statistical controls in assessing the contributions of various ecological variables to the social phenomenon of interest, (b) allows the representation of considerable complexity in the relations among variables, and (c) if some strong assumptions are plausible, it provides a way to make some weak probes of causal hypotheses using only correlational evidence. The assumptions underlying path analysis are well known (Alwin and Hauser, 1975; Blalock, 1975),

and are often reiterated by authors of reports of applications of the technique. The purpose of the present report is to illustrate how difficult it may be to have reasonable confidence that the assumptions required for straightforward interpretation have been met. This purpose is pursued by using an ecological analysis of high school crime rates as an illustration.

The following sections outline the method used and present the results of an ecological examination of high school crime rates in a way which parallels typical reports of ecological studies (e.g., Bidwell and Kasarda, 1975; Hicks et al., 1978). The model specified to explain high school crime rates is then applied to the prediction of unrelated social phenomena. This unusual additional step makes it clear that results which would usually be interpreted as school system contributions to the explanation of crime rates may plausibly be considered spurious despite careful attempts to specify a reasonable model and the apparent reasonableness of the results. Finally the implications of the present case study for future research are discussed.

The Problem of School Crime

Concern about delinquency and disruptive behavior in the nation's schools is manifested by recent cover stories in the major national news-magazines ("City Schools in Crisis," 1977; "High Schools Under Fire," 1977) and by extensive Congressional inquiry (Committee on the Judiciary, 1975; 1976a; 1976b; 1976c; 1977). These reports, together with reports published annually by the Federal Bureau of Investigation (Kelley, 1977), may not only reflect public concern

about high levels of crime in general and in schools in particular, but they may also contribut to the level of concern. National surveys (Gallup, 1974; Garofalo, 1976) imply that the public believes that crime in the schools is a problem and that crime in general is increasing.

Only limited data on the actual extent of crime in schools are available, and reports of trends in crime rates are often misleading or difficult to interpret (Rubel, 1977). The recent report of the Safe School Study (National Institute of Education, 1977) reviews the evidence from surveys and official sources and concludes that there is little to suggest a rise in school crime or violence since 1970. Although school crime may not be increasing, both the Safe School Study and evidence from victimization surveys (McDermott and Hindelang, 1977) imply that school crime and violence are serious problems. McDermott and Hindelang's analysis of victimization reports for 28 cities in the LEAA-Census Bureau surveys implies that, for persons aged 16 to 19, 42% of rapes, 25% of robberies, 25% of aggravated assaults, 27% of simple assaults, 30% of larceny with contact, and 31% of larceny without contact occur in schools.

For practical reasons it is important to know if there are particular school characteristics that contribute to crime rates in schools. The Safe School Study reports extensive descriptive information about school and community characteristics that are associated with students' reports of personal victimization. In some analytical work included in the report, school violent crime rates or property crime rates were regressed on such local or school variables as

community crime, percentage of students male, school average internal control scores for students, average grades, school governance practices as reported by students, other school practices as reported by students, and ethnic and economic status of the studentry. The purpose of these analyses was to learn if any of the variables studied had effects on school crime rates.

These ecological investigations of potential school effects (all analyses were conducted on data aggregated at the school level) are interesting but difficult to interpret for three reasons.[1/] First, most of the predictors are based on student reports. The fairness of school discipline, for example, was measured by aggregating student opinions on this matter. Because measures of school crime levels also are based on student reports of personal victimization, there is a possibility that some of the association between predictors and criteria may be due to the common method by which data were obtained (cf. Campbell and Fiske, 1959; Heise, 1969). Second, the use of the community crime level as a statistical control when assessing the effects of other variables may be equivalent to controlling on the criterion itself. For example, student reports of fighting gangs in the neighborhood--one component of the community crime score--may be related to reports of victimization for obvious reasons. Third, in order to make interpretations about the effects of variables, one must be confident that substantially all of the causes which may be correlated with other predictors are included in the statistical model and that the causal sequence specified is appropriate. In the Safe School Study analyses, a large number of local and school

characteristics (such as educational expenditures) are omitted from the analyses, and the sequencing of potential causes sometimes seems questionable. For example, the percentage of students white is included in the analysis in a way that implies that variables such as school average internal control scores for the studentry affects the percentage of the studentry which is white.

Analyses that add to knowledge in the way intended in the Safe School Study are difficult to accomplish, and criticisms of the type just mentioned could be applied with equal relevance to much of the measurement-based social science literature. There remains, however, the potential to remedy these analytical defects in new analyses of the Safe School Study data.

Because much of the data relating to crime or delinquency is collected or reported in aggregated form only, this is the only level at which a study may proceed. Data on the distribution of general crime rates are available at city, SMSA, and state levels. Currently, information about the geographical distribution of school crime rates is available only at the state level. This information comes from a National Center for Education Statistics study conducted in 1974 and described in the Safe School Study report (National Institute of Education, 1977). As is often the case with government reports, information is reported as state rates per 1,000 students and no further examination is made. These rates show substantial variation with 4.18 offenses per 1,000 students reported to the police in West Virginia and Mississippi and 23.59 in New York. The NCES data are used to explore the application of a human ecological approach to the study of the geographical distribution of high school crime rates.

Although many important research questions pertain to individual-level processes, aggregate level analyses are also needed. The explanation of crime rates is at least as important as the explanation of individual participation in crime. People's perceptions of the social ecology of crime probably play salient roles in their housing and schooling decisions. In addition, hypotheses about state laws, expenditures or administrative practices may best be examined using state level analyses.

Rationale, Research Plan, and Methods

As noted earlier, the purpose of the present research is twofold: (a) to assess the usefulness of the human ecological approach to the study of the geographical distribution of social problems, as well as (b) to learn as much as possible about the distribution of high school crime. This research is a case study in the methodology of ecological analysis, including examination of its pitfalls as well as its potential. Consequently, the methods and predictors used in the examination of crime rates will be used in an attempt to describe the distributions of some other social problems, the explanations of which are expected to differ from reasonable explanations of the distribution of school crime. The following paragraphs present the rationale for the methods used and describe the hypothetical model that forms the research plan.

A path analytic strategy was used to structure the examination of the relation of some state school system characteristics that appear manipulable by states to state rates of high school crime. All variables are aggregated at the state level and consequently

results are interpretable only at this level. Any practical implications of the research would therefore apply only to state school system strategies and not necessarily to school districts, schools, or individuals. In the particular model used the assumptions required for assessing causal hypotheses are that all causes of the high school crime rate that are correlated with any predictors already represented in the model are also in the model and are measured without error, and that the directions of causality are as indicated in the model ($A \rightarrow B$) rather than the reverse or mutual (i.e., that $A \leftarrow B$ or $A \rightleftarrows B$).[2/]

Because the methods used may not be familiar to all readers and because some of the terms used here differ from those usually applied, some introduction may be helpful. In general the analytic strategy outlined by Alwin and Hauser (1975) is applied although some of their terms are changed to emphasize the weak quasi-experimental nature of the research.[3/] Distinctions are made among total associations, total contributions, direct contributions, and indirect contributions. The total association between any predictor and the criterion is the zero-order (ordinary) correlation between them. In contrast, the total contribution is that association which (given the assumptions) is not due to a common cause of both the predictor and the criterion nor to separate causes of the two variables which are correlated with each other, nor to potential explanatory prior variables which have not been analyzed. The direct contribution of a predictor to the statistical explanation of the criterion is that part of its total contribution which is not transmitted via intermediaries (given

the assumptions). The indirect contribution of a predictor occurs (given the assumptions) via an intermediary variable. If the model is correctly specified and measurement is errorless, an indirect contribution would indicate how much of the total contribution to explanation of the criterion is gained because the predictor contributes to the explanation of intermediaries which in turn contribute to explanation of the criterion. Obviously, the results and their reasonable interpretation require careful specification of the sequence via which variables are construed to influence each other.

In practical application (still following Alwin and Hauser, 1975), the criterion is sequentially regressed on predictors. The total contribution of a predictor is obtained by calculating the standardized partial regression coefficient in what is assumed to be the most causally prior regression of the criterion on a predictor or set of predictors. Direct contributions are obtained by calculating the standardized partial regression coefficients (β weights) when the criterion is regressed on a set of predictors which includes all of the potentially explanatory variables simultaneously. Direct contributions are often called path coefficients. Indirect contributions made via specific intermediary variables (as opposed to total indirect contributions) are calculated by multiplying the path coefficient for the direct contribution of the prior variable to the intermediary variable by the total contribution of the intermediary. If the model is correctly specified and there is no measurement error, these indirect contributions via specific intermediary variables convey information about the plausibility of hypotheses about the mechanism

by which a particular predictor operates to explain variance in the criterion. It is customary to speak of the partitioning of the total contribution into its components as the decomposition of contributions.

The specific model used to guide the present research is illustrated in Figure 1. It is a fully recursive model with all possible paths. The diagram is abbreviated. It shows only one arrow, for example, from the entire set of exogenous[5] variables to each subsequent variable. Similarly, the double headed arrows typically used to imply correlation among the exogenous variables are not shown. These details are omitted to simplify the portrayal of a complicated model that would otherwise appear as a tangle of arrows. The following paragraphs describe the model and the rationale for the inclusion of specific variables.

Insert Figure 1 About Here

Exogenous Variables

Lacking from many applications of path analyses in social science research is good reason for assuming that most determiners of the criterion which may be correlated with other variables in the model are themselves represented in the model. The approach taken in the present research to this specification problem is to make use of an earlier factor analysis of state characteristics (Richards, 1977) in an effort to comprehensively represent the major characteristics of states as a set of five exogenous variables. Most of the data for Richard's factor analysis are from the 1972 County and City Data Book (U.S. Bureau of the Census, 1972).[6]

1. The first factor, emphasis on large-scale agriculture (LARGEAG), describes states with a large land area, relatively large income relative to labor force from farm sales, and relatively large income per farm from field crops and livestock.

2. Population size (POPSIZ) describes states with large populations, extensive professional education, and relatively low male:female ratios.

3. Affluence-urbanization (AFFURB) describes states with high family income, a large portion of the population in urban areas, and a relatively high proportion of high school graduates among the adult population. Agriculture is relatively less extensive in states with high scores in this factor.

4. White predominance (WHITE) describes states with a high proportion of the population white.

5. Emphasis on specialized agriculture (SPECAG) describes states with relatively large income per farm from daily products, poultry, and horticulture other than field crops; and relatively high income relative to labor force from manufacturing.

Intermediary State Characteristics

6. Compulsory school attendance laws (ATDLAW) differ considerably from state to state (Children's Defense Fund, 1974). These laws may influence high school crime rates either by compelling persons who are discontented with school to attend, thus contributing to disruptive behavior, or by compelling persons who would commit crimes wherever they were to attend school and thus commit the crimes there. Attendance laws are represented in the present research by the age through which youth are required to attend school.

7. Unemployment rates (UNEMP) have often been shown to be correlated with crime rates, and individual participation in crime appears correlated with employment status or prospects (Evans, 1968; Fleischer, 1966; Glaser, 1964; Cook, undated). General statewide unemployment may be related to youths' legitimate opportunities to obtain social or economic rewards and thus contribute to the explanation of their participation in crime or rebellion. State unemployment rates for 1974 (Employment and Training Administration, 1976) were used.

Intermediary School System Characteristics

8. Average daily attendance per school (ADA/SCH) in 1973-74 (Scott and Dunn, 1976) was used as a general measure of typical school size in a state system. There is substantial variability in this statewide average, ranging from 162 for Nebraska to 739 for Hawaii. School size was related to school victimization rates in the National Institute of Education (1977) study and to principals' reports of crime problems in a study by McPartland and McDill (1977). A school system in which typical schools are small would probably be one in which administrators have closer contacts with students. This could lead to more informal supervision and fewer crimes reported to the police or, alternatively, a higher proportion of crimes detected and higher reporting rates.

9. The ratio of persons enrolled in public schools in grades 9-12 to persons aged 14-17 (ENROLL) in the state in 1973-74 (calculated from Scott and Dunn, 1976) was used as a measure of the comprehensiveness with which high school aged youth participate in secondary

education. It is expected that part of any contribution of compulsory school attendance laws to high school crime would be made via this route, and that states with higher proportions of youth enrolled would have higher school crime rates because potential trouble makers are in rather than out of school.

10. Expenditures per pupil in average daily attendance (EXPEND) in 1973-74 (Scott and Dunn, 1976) was used as a general measure of state school system resources. This variable is highly correlated with average teacher salary ($r = .86$) in the present data and school resources per pupil was highly correlated ($r = .67$) with pupil:teacher ratios at the school system level of aggregation in Bidwell and Kasarda's (1975) report. Student:teacher ratios were not examined in the present research because ratios calculated from the NCES source used (Scott and Dunn, 1976) did not appear credible. It is assumed that expenditures per student is a reasonable measure of school resources and that avoiding the complications of including additional measures which are closely linked theoretically and statistically would be desirable. Under the present circumstances it is difficult to decide whether including rather than excluding one of these variables constitutes the greater specification error.

The Principal Criterion

11. The number of high school crimes reported to the police per thousand students (HSCRIM) is the criterion. The data are from a study (National Institute of Education, 1977) conducted by the NCES. School authorities were asked in a mail survey to indicate the number of crimes reported to the police in a 5-month period between 1 September

1974 and 31 January 1975. The sample was designed to be representative of each state. Not enough information is provided in the original report to estimate the magnitude of sampling errors for state rates, but they are probably moderately high. Potential sources of bias in the estimates appear to include those due to (a) the time period covered, (b) the difference in state school system policies with regard to the kinds of offenses which should be reported to the police, (c) differences in record-keeping practices that would affect the comprehensiveness of reporting, and (d) differences in willingness to report these data for various reasons.

It is important to note that crime reported to the police rather than self-reports of crime participation or of incidents of victimization is the criterion. There is evidence (McDermott and Hindelang, 1977) that few in-school victimizations are reported to the police (at least as far as the victims knew). Nine out of ten victimizations of urban school students and three of four of urban teachers and staff were not reported. More serious offenses are probably reported more frequently. Although the source and comprehensiveness of reports is always a consideration, Hindelang's (1974) comparison of the geographic distribution of Uniform Crime Reports homicide rates with estimates of homicide rates made with National Opinion Research Center victimization survey data and with Center for Health Statistics data imply that aggregate data from different sources often show similar patterns of offense distribution. Patterns in distribution rather than absolute levels are the concern of the present research.

Alternative Criteria

One way to assess the credibility of the results obtained in this kind of research is to determine whether the pattern of results obtained for the criterion of interest (here school crime) diverges from patterns obtained for other criteria believed to be explained by different models than is the criterion of interest. To enable this kind of examination the following three alternative criteria were used:

12. The gonorrhoea rate per 100,000 population in 1974 (National Center for Health Statistics, 1976).

13. The mortality rate due to motor vehicle accidents for the period 1969-71 (Health Resources Administration, 1976).

14. The mortality rate due to heart diseases for the period 1969-71 (Health Resources Administration, 1976).

Prior to analysis, most of the variables were subjected to a normalizing transformation based on rank order.[7/] Each score was transformed to a new value based on the z-score for its rank in a normal distribution. Similar transformations are common in ecological research (Bidwell and Kasarda, 1975; Harries, 1976). A comparison of log transformations with the procedure used implied that log transformations were inferior to an extent that justified use of the more laborious method. These nonlinear transformations imply that transformed scores and original scores rank order the states in the same way, but that the influence of extreme cases on the correlations among the variables is reduced. The only variables not subjected to this transformation were the factor scores for the exogenous

variables. These are scores on mutually independent (orthogonal) factors and were nicely distributed to begin with.[8/] Because all states were included in the study, measurement and specification rather than sampling are the major sources of error. Consequently, the customary procedure of assessing the ratio of regression coefficients to their sampling error is omitted.

Results

High School Crime

The first three tables present the results for the criterion of high school crime. Table 1 shows the residuals (contributions of unmeasured variables) and path coefficients for each path in the model. In most cases the residuals are relatively small compared to those obtained in other path analytic work, even in ecological analyses (cf. Bidwell and Kasarda, 1975; Miller and Stokes, 1975). This is reassuring because larger residuals would appear to constitute *prima facie* evidence of the untenability of the assumptions undergirding the method. One residual contribution is quite large, however, implying that variations in state compulsory attendance laws are not well explained by the exogenous variables. In general the pattern of path coefficients in Table 1 appears reasonable. Affluence-urbanization, for example, makes a large direct contribution to expenditure per pupil.

Insert Table 1 About Here

Table 2 presents the results of the decomposition of the total contributions to the explanation of school crime rates into direct and indirect components. As is usually to be expected, the application

of statistical controls for exogenous and prior variables results in total contributions that are smaller than the total associations. Affluence-urbanization makes the largest total contribution to high school crime rates. Almost all of this contribution is indirect. Unemployment rates and attendance laws make some direct and almost no indirect contributions. Two of the three school system characteristics (average daily attendance per school and expenditures per pupil) make fairly sizeable contributions directly, i.e., even with all the other variables simultaneously in the model. The interpretation of the exogenous variables other than affluence-urbanization is unclear in the absence of explicit hypotheses. They serve here primarily as a reasonably comprehensive set of statistical controls.

Insert Table 2 About Here

Table 2 shows more details of the indirect contributions by decomposing them into contributions via specific intermediary variables. Only affluence-urbanization makes a large total indirect contribution and this appears to be primarily because of its indirect contributions via expenditures per pupil and unemployment. The rest of the indirect paths are difficult to interpret. The lack of an indirect contribution of attendance laws via enrollment rates is interesting, however.

Insert Table 3 About Here

Alternate Criteria

The model assumed to be reasonable for the study of high school crime rates was applied to three criteria for which it seems inappropriate--rates of gonorrhoea, motor vehicle fatalities, and

heart fatalities. Only the criterion variable is changed and consequently the changes in the results are all attributable to changes in the standardized partial regression coefficients in the regression of the criterion on all predictors at once. This is illustrated in Table 4, which shows the direct path coefficients for all three alternate criteria. The residuals shown in Table 4 are about as small as, and in one case substantially smaller than, the residual when predicting high school crime rates.

Insert Table 4 About Here

The examination of the results for attendance law, average daily attendance, enrollment, and expenditures per pupil in Tables 5-7 are of interest. Although correlations between the criteria and these variables might be expected for a variety of reasons, there is no reason to believe that any of these variables will contribute to the explanation of any of the criteria in other than a purely actuarial sense. The contributions of these variables to gonorrhoea rates are not large. For motor vehicle fatalities, however, two of the four make fairly sizeable contributions, and one makes a large contribution. For heart disease, one of these variables makes a moderate contribution.

Insert Tables 5-7 About Here

For completeness, Table 8 shows the decomposition of indirect contributions for the three alternate criteria.

Insert Table 8 About Here

Random Variables

In an attempt to examine the outcome of analyses in which no plausible theoretical explanations at all could be developed for a sizeable contribution to explanation, several normal random variables were constructed. Table 9 shows results when the predictors in the model for school crime are regressed on four random normal variables. A number of the direct contributions shown in the table are large, although the residuals are also large. (Large partial regression coefficients may be obtained together with small R^2s. This is because R^2 equals the sum of the products of the partial betas and the zero-order correlations, which may be quite small.)

Insert Table 9 About Here

Discussion

The discussion will proceed in two parts. First, I shall suspend disbelief and discuss the substantive results for high school crime rates in a way that such analyses are typically discussed. Then I will discuss the results for the alternative criteria and random variables and the insight they provide about potential problems in this kind of research.

High School Crime Rates

The results presented earlier in Tables 1 to 3 sometimes appear reasonable. The affluence-urbanization of a state makes the largest total contribution to the explanation of high school crime. It makes this contribution chiefly via expenditures per pupil and unemployment. Affluent, urban states have high rates of high school crime, and the

greater a state school system's per pupil expenditures and the higher the state's unemployment rate the higher the rate of high school crime. The result for unemployment seems reasonable, but the result for school system expenditures is puzzling.

The largest direct contributions (all positive) to high school crime are from emphasis on large-scale agriculture and expenditures per pupil. Attendance laws, unemployment rates, and typical school size (ADA/SCH) make moderate positive direct contributions, and state population size makes a moderate negative contribution.

Compulsory school attendance laws make a moderate direct contribution to reported crime rates, and almost no indirect contribution via any school system variable. No evidence would imply that these laws explain school crime by increasing the proportion of the eligible population which is enrolled as anticipated. This result leads to the speculation that when law compels attendance, school systems may resort to use of the criminal justice system as a means of exercising control over disruptive students. The predictors making the largest direct contribution to enrollment rates are white predominance and emphasis on large scale agriculture. States with relatively small proportions of the high school aged population in high school are those with a large proportion of their population nonwhite and with little large scale agriculture. Because both WHITE and LARGEAG are exogenous variables, the explanatory possibilities are unanalyzed in the present research.

The largest direct contributions to expenditures per student are affluence-urbanization and white predominance. Emphasis on large

scale agriculture makes a moderate negative contribution to expenditures, and unemployment makes a moderate positive contribution. This last result requires some imagination to rationalize, and most rationalizations seem to lack credibility, but one might speculate that states with unemployment problems may, other things being equal, increase expenditures on education in the belief that this will assist students in their later labor market competition.

The interpretations suggested in the foregoing paragraphs are worded as if the assumptions underlying the application of path analysis to decompose correlations into causal or explanatory contributions have been met and that the variables studied are reasonable measures of the intended school system or state characteristics. In one case, compulsory attendance laws, the residual is so large that it may be best to regard its causes as unanalyzed (or misspecified) and only extremely cautious interpretations would be warranted. Evidence is lacking to evaluate the extent of measurement error, and several ambiguities about the best way to specify the model have already been noted. For these reasons the present results should be regarded as grounds for speculation rather than as a demonstration of effects.

The results suggest some speculations with policy relevance. First, state changes in compulsory attendance laws that would increase the age through which youth are required to attend school may lead to a small increase in the proportion of high school aged youth actually enrolled, and may also lead to higher rates of high school crimes reported to the police. Second, increasing the size of typical schools

in a system may lead to a small increase in rates of crime reported to the police. Third, spending less money per student in a state system may decrease the rate of crimes reported to the police. This last result does not imply that large, immediate cuts in state education budgets may be the best way to fight crime (although had the results been opposite the actual results I have little doubt that they would have received the interpretation that increasing per pupil expenditures might reduce crime). More plausible interpretations imply that school systems with more resources are more often the victims of serious vandalism or that these schools more often make use of formal criminal justice sanctions.

More powerful quasi-experimental designs are required to learn whether any of these speculations have merit. Such designs might include the use of interrupted time series to assess the effects of changes in attendance laws or their enforcement, changes in state educational expenditures, or administrative changes relating to school size. In order to perform such quasi-experimental tests, time series data on school crime would be required. At present no time series crime data are being collected that would enable researchers to take advantage of natural quasi-experimental opportunities resulting from state law or policy changes. Collecting such data would be desirable.

Insights from the Examination of Alternate Criteria

Because the foregoing discussion includes little in the way of critical examination of the original model, examining the results of the ancillary analyses is important. These results have implications

for the confidence one may have in the earlier speculations. Were one to accept the results for the alternate criteria uncritically, one would conclude that higher expenditures per student in a state school system contribute to a lowering of the death rate due to motor vehicle fatalities but to a small increase in death due to heart disease. Such conclusions are silly because the findings are not explained by any reasonable hypotheses about the causes of these social problems and because the health data are rates for earlier years than the school system data. The "direct contributions" are spurious.

Exponents of path analysis (e.g. Alwin and Hauser, 1975) speak of the technique as a way of decomposing correlations into effects, and into spurious correlation which is due to the predictor and criterion sharing common causes or correlated causes. They also speak of unanalyzed causes of exogeneous variables. As the exponents note, the validity of conclusions regarding effects depends on the correct specification of the model, and they would acknowledge that specification error would render conclusions about effects invalid.

The principle insight gained by examining the alternative criteria in the present research results from the simple demonstration that implausible results are fairly easy to obtain.[9/] The results make path analysis questionable as even a weak form of quasi-experimental investigation because it is very difficult (or perhaps impossible) to tell when a model has been correctly specified. Results that appear plausible because they accord with hypotheses may in fact be spurious. The results for the alternate criteria imply that some

school system variables are correlated with other variables not included in the model which would be useful in explaining the alternate criteria. There is no clear way to tell whether excluded variables would also be correlated with high school crime rates. In the absence of evidence to the contrary it appears safest to assume that specification error is a plausible threat to the internal validity of the high school crime study. This conclusion is drawn despite the relatively small residuals in comparison with other path analytic research (cf. Miller and Stokes, 1975).

The examination of the alternative criteria also makes salient another potential pitfall in this kind of work. This problem is well known, but it perhaps requires reiteration here. Standardized partial regression coefficients are sensitive to changes in the variables included in the regression equation (Darlington, 1968; Gordon, 1968). Path coefficients (direct contributions) are standardized partial regression coefficients in equations including all predictors with direct paths to the criterion. When, as is often the case, one is dealing with fallible measures of unobserved causal variables it may be possible for these fallible measures to share in the "explanation" of a criterion even though none of them is in a strict theoretical sense a cause of the criterion. For example, state scores on Richards' (1977) affluence-urbanization factor are calculated from fallible scores on a number of observed variables. Expenditures per student is another fallible observed variable. If AFFURB and EXPEND are simply alternative measures of some unobserved hypothetical cause it is reasonable to expect them to share in the explanation of any

criterion caused by the hypothetical (unobserved) variable. This conceptualization of the problem provides one explanation of the direct contribution of expenditues in the study of the alternative criteria. It may also provide an alternative way to interpret the otherwise puzzling result from the study of school crime that increased expenditures per pupil would contribute to increased crime.

The results of the analyses in which the model specified for high school crime was used to predict the random variables shows how dangerous the interpretation of partial regression coefficients in ecological analyses employing a small number of ecological units can be. In these analyses (which constitute a sort of poor man's Monte Carlo investigation) it is apparent that regression coefficients which appear large enough to interpret may be fairly easily obtained. These results undermine the confidence in any interpretations of the earlier results.

In view of the results of the study of alternate criteria and random variables, it appears even more important to emphasize that the path analytical approach to the ecological study of school crime provides only a weak probe of causal hypotheses. The kinds of policy implications sometimes drawn by researchers on the basis of similar correlational studies (Bidwell and Kasarda, 1975 to cite only one example) using different criteria seem incautious in the context of the ambiguities inherent in measurement-based research. Perhaps the most important policy implication that can be drawn from the present case study in research methodology is that data which would enable more rigorous research on the causes of high school crime rates

are needed. Because it appears unlikely that true experiments will be possible in this area, one way to achieve better research would be to take steps to facilitate the possibility of good quasi-experimental research on the effects of any changes in school-system organization when they occur naturally. Establishing a mechanism to routinely collect time series data on school crimes of various types from a large number of school systems would enhance the potential of high quality research in the future. Funding such an activity may appear unattractive to educational research policy makers because it lacks the appearance of immediate research payoffs and because of causal modeling's obvious appeal. In the long run, however, efficient research may be research which withstands the temptation to seek weak causal inferences.

Footnotes

[1]See Emrich (1978) for additional criticisms.

[2]Readers not familiar with path analysis or so-called causal modelling may find it helpful to read Blalock (1971) and Cook and Campbell (1976).

[3]Some translations are as follows: effect = contribution, independent variable = predictor, dependent variable = criterion, intervening variable = intermediary. Most of these substitutions remove language that is more appropriate in a randomized agricultural experiment involving the application of fertilizer and bushels of corn per acre than to the present study.

[4]Explanation is used loosely here. See Harvey (1969) and Salmon (1971). In the present context explanation means that a predictor can account for variance in the criterion.

[5]An exogenous variable is one for which the causes are unanalyzed in the model under consideration.

[6]These factors may be viewed as "unobserved" variables which "cause" the original variables analyzed by Richards. The standard deviation of the unobserved variables is not known, so the standard deviation of the factor scores is arbitrary. Therefore, although examination of metric coefficients based on original measures is sometimes recommended (Kim and Mueller, 1976), it is not appropriate to compute unstandardized (metric) coefficients for these variables.

[7]This transformation was performed to eliminate the extreme

skewness of some variables and to make explicit the assumption that measures bear at most an ordinal relation to any hypothetical variables. The unknown form of "true" distributions is an additional reason for reporting only standardized regression coefficients in this report. The unstandardized coefficients would have no particular meaning.

[8]Subsequent to the analyses reported here, the distribution of normalized factor scores was examined. The means and standard deviations differed little from the untransformed scores.

[9]These results cannot be attributed to the use of standardized regression coefficients. In each case where the standardized coefficient is substantial the corresponding unstandardized coefficient would also indicate a substantial relation.

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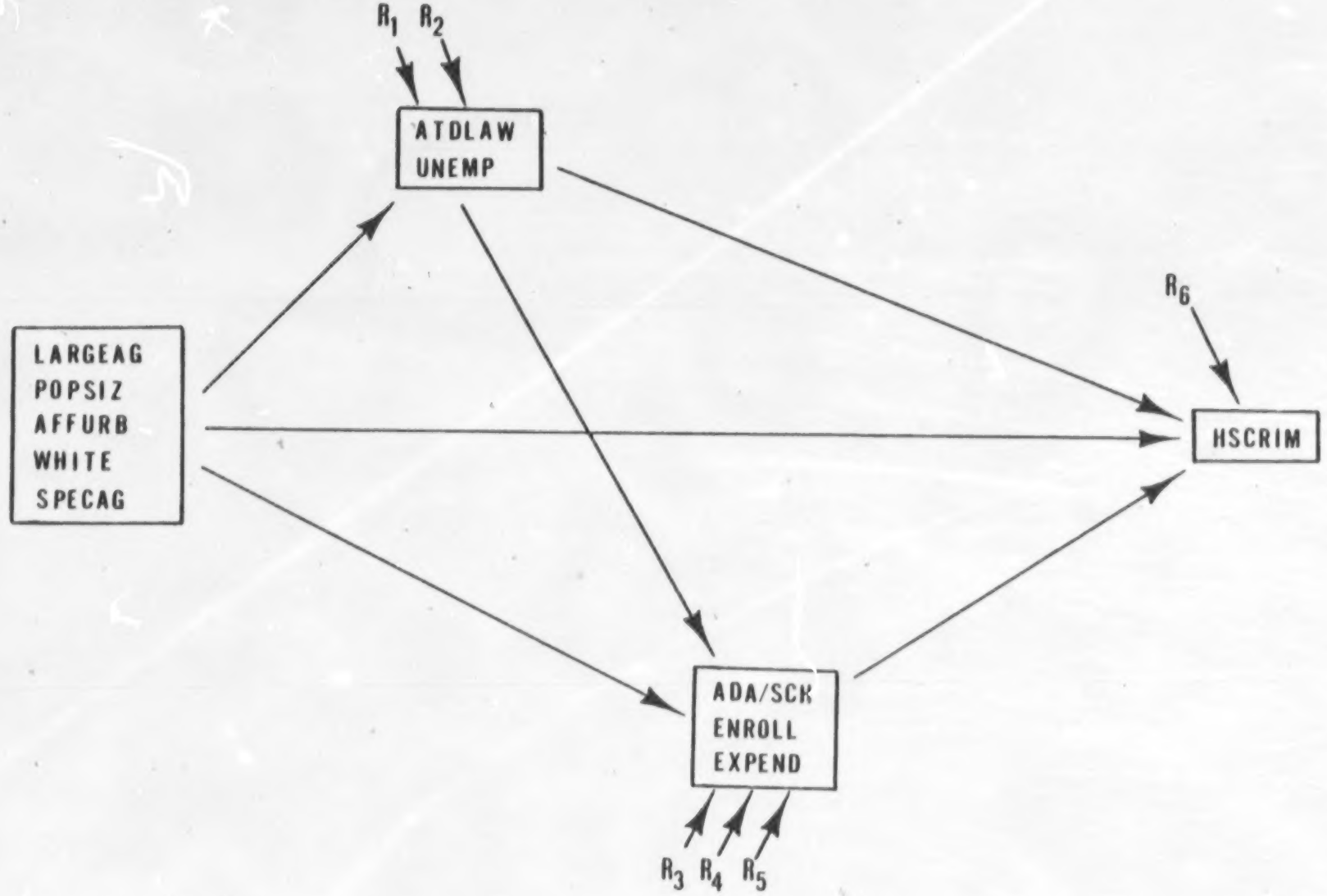

Figure 1. The Model Guiding the Research

Table 1

Path Coefficients in the Model of
Rates of High School Crime Reports

	criterion					
Predictor	ATDLAW	UNEMP	ADA/SCH	ENROLL	EXPEND	HSCRIM
LARGEAG	.137	-.099	-.066	.352	-.240	.425
POPSIZ	.063	-.147	.291	-.128	.157	-.278
AFFURB	.259	.583	.497	.131	.552	.090
WHITE	.020	-.202	-.606	.511	.312	.117
SPECAG	-.040	.348	.401	.094	-.098	-.105
ATDLAW	--	--	.015	.198	-.170	.216
UNEMP	--	--	-.212	-.018	.211	.216
ADA/SCH	--	--	--	--	--	.219
ENROLL	--	--	--	--	--	-.082
EXPEND	--	--	--	--	--	.383
Residual	.953	.679	.550	.710	.636	.636

Table 2

Associations of State Characteristics with Rates of High School Crime Reported to the Police; and Total, Direct and Indirect Contributions in a Path Model of High School Crime Reports

State characteristic	total association	contribution		
		total	direct	indirect
LARGEAG	.287	.284	.425	-.141
POPSIZ	-.173	-.172	-.278	.106
AFFURB	.584	.582	.090	.492
WHITE	.011	.014	.117	-.103
SPECAG	.023	.020	-.105	.125
UNEMP	.478	.251	.216	.035
AIDLAW	.337	.137	.216	-.079
ADA/SCH	.212	.219	.219	--
ENROLL	.226	-.082	-.082	--
EXPEND	.444	.383	.383	--

NOTE: R^2 = .595, residual = .636. The first five state characteristics are based on factor scores. Consequently the total associations (zero-order correlations) equal their standardized partial regression coefficients in equations including only these five variables as predictors except for rounding errors. For this reason their total associations approximately equal their total contributions.

Table 3

Decomposition of the Indirect Contributions of State Characteristics in the Model of Rates of Reported High School Crime

State characteristic	path via ATDLAW	UNEMP	ADA/SCH	ENROLL	EXPEND
ATDLAW	--	--	.003	-.016	-.065
UNEMP	--	--	-.046	.001	.081
LARGEAG	.019	-.025	-.014	-.029	-.092
POPSIZ	.009	-.037	.064	.010	.060
AFFURB	.035	.146	.109	-.011	.211
WHITE	.003	-.051	-.133	-.042	.119
SPECAG	-.005	.087	.088	-.008	-.038

Table 4

Path Coefficient Developed in the Application of the High School Crime Rate Model to Data on Gonorrhoea, Motor Vehicle Fatality, and Heart Disease Death Rates

	criterion							
Predictor	ATDLAW	UNEMP	ADA/SCH	ENROLL	EXPEND	VDRATE	MVFAT	HTFAT
LARGEAG	.137	-.099	-.066	.352	-.240	.334	.343	-.464
POPSIZ	.063	-.147	.291	-.128	.157	.227	-.157	.205
AFFURB	.259	.583	.497	.131	.552	-.098	-.333	-.264
WHITE	.020	-.202	-.606	.511	.312	-.789	-.047	-.297
SPECAG	-.040	.348	.401	.094	-.098	-.002	-.490	.341
ATDLAW	--*	--	.015	.198	-.170	-.094	-.195	.055
UNEMP	--	--	-.212	-.018	.211	.152	.288	-.183
ADA/SCH	--	--	--	--	--	-.121	.039	.028
ENROLL	--	--	--	--	--	.022	.276	-.043
EXPEND	--	--	--	--	--	.143	-.429	.220
Residual	.953	.679	.550	.710	.636	.601	.460	.666

Table 5

Application of the Model Specified for High School Crime Report Rates to Data on Gonorrhoea Rates: Total Associations and Total, Direct, and Indirect Contributions

State characteristic	total association	contribution		
		total	direct	indirect
LARGEAG	.279	.279	.334	-.055
POPSIZ	.173	.173	.227	-.054
AFFURB	.019	.014	-.098	.112
WHITE	-.703	-.704	-.789	.085
SPECAG	.017	.014	-.002	.016
UNEMP	.187	.208	.152	.056
ATDLAW	-.038	-.115	-.094	-.021
ADA/SCH	.409	-.121	-.121	--
ENROLL	-.295	.022	.022	--
EXPEND	-.156	.143	.143	--

NOTE: R^2 = .638, residual = .601. The first five state characteristics are based on uncorrelated factor scores. Consequently the total associations (zero-order correlations) equal their standardized partial regression coefficients in equations including only these five variables except for rounding error.

Table 6

Application of a Model Specified for High School Crime Report Rates to Data on Motor Vehicle Fatality Rates: Total Associations and Total, Direct, and Indirect Contributions

State characteristic	total association	contribution		
		total	direct	indirect
LARGEAG	.512	.514	.343	.171
POPSIZ	-.279	-.279	-.157	-.122
AFFURB	-.423	-.424	-.333	-.091
WHITE	-.100	-.103	-.047	-.056
SPECAG	-.348	-.339	-.490	.151
UNEMP	-.281	.184	.288	-.104
ATDLAW	-.081	-.066	-.195	.129
ADA/SCH	-.339	.039	.039	--
ENROLL	.227	.276	.276	--
EXPEND	-.626	-.429	-.429	--

NOTE: R^2 = .788, residual = .460. The first five state characteristics are based on uncorrelated factor scores. Consequently the total associations equal their total contributions except for rounding error.

Table 7

Application of a Model Specified for High School Crime Report Rates to Data on Heart Disease Death Rates: Total Association and Total, Direct, and Indirect Contributions

State characteristic	total association	contribution		
		total	direct	indirect
LARGEAG	-.520	-.519	-.464	-.055
POPSIZ	.276	.275	.205	.070
AFFURB	-.215	-.216	-.264	.048
WHITE	-.238	-.238	-.297	.059
SPECAG	.281	.277	.341	-.064
UNEMP	-.033	-.142	-.183	.041
ATDLAW	-.135	.010	.055	-.045
ADA/SCH	.288	.028	.028	--
ENROLL	-.396	-.043	-.043	--
EXPEND	.056	.220	.220	--

NOTE: R^2 = .557, residual = .666. The first five state characteristics are based on uncorrelated factor scores so their total associations equal their total contributions except for rounding error.

Table 8

Decomposition of the Indirect Contributions of State Characteristics When the Path Model for High School Crime Rates is Applied to Data for Gonorrhoea, Motor Vehical Fatality, and Heart Disease Death Rates

Criterion variable	state characteristic	path via				
		ATDLAW	UNEMP	ADA/SCH	ENROLL	EXPEND
VDRATE	ATDLAW	--	--	-.002	.004	-.024
	UNEMP	--	--	.026	.000	.030
	LARGEAG	-.016	-.020	.008	.008	-.034
	POPSIZ	-.007	-.030	-.035	-.003	.022
	AFFURB	-.030	.121	-.060	.003	.079
	WHITE	-.002	-.042	.073	.011	.045
	SPECAG	.005	.072	-.048	.002	-.014
MVFAT	ATDLAW	--	--	.000	.055	.073
	UNEMP	--	--	-.008	-.005	-.090
	LARGEAG	-.009	-.018	-.002	.097	.103
	POPSIZ	-.004	-.027	.011	-.035	-.067
	AFFURB	-.017	.107	.019	.036	-.237
	WHITE	-.001	-.037	-.024	.141	-.134
	SPECAG	.003	.064	.016	.026	.042
HTFAT	ATDLAW	--	--	.000	-.008	-.037
	UNEMP	--	--	-.006	.001	.046
	LARGAG	.001	.014	-.002	-.015	-.053
	POPSIZ	.001	.021	.008	.006	.034
	AFFURB	.002	-.083	.014	-.006	.121
	WHITE	.000	.029	-.017	-.022	.069
	SPECAG	-.000	-.049	.011	-.004	-.022

Table 9

Standardized Partial Regression Coefficients in the Prediction of Four Random Variables

Predictor	RAND 1	RAND 2	RAND 3	RAND 4
LARGEAG	-.033	-.068	.063	.347
POPSIZ	.023	.404	.047	.030
AFFURB	-.111	.009	.087	-.176
WHITE	.150	.060	-.504	.550
SPECAG	.016	.124	.007	-.341
ATDLAW	.138	.069	.040	.230
UNEMP	-.260	.039	-.241	.490
ADA/SCH	.081	-.125	-.363	.344
ENROLL	.064	.083	.070	-.500
EXPEND	.162	-.013	.148	-.169
Residual	.934	.906	.933	.832
R^2	.126	.179	.129	.308